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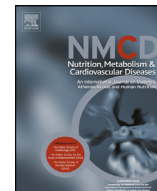
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# The relationship of health/food literacy and salt awareness to daily sodium and potassium intake among a workplace population in Switzerland

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## KEYWORDS

Sodium;  
Potassium;  
Na/K ratio;  
Health literacy;  
Food literacy;  
Salt awareness;  
24-h urine;  
Hypertension

**Abstract** *Background and aims:* High sodium (Na) and low potassium (K) intake are associated with hypertension and CVD risk. This study explored the associations of health literacy (HL), food literacy (FL), and salt awareness with salt intake, K intake, and Na/K ratio in a workplace intervention trial in Switzerland.

*Methods and results:* The study acquired baseline data from 141 individuals, mean age 44.6 years. Na and K intake were estimated from a single 24-h urine collection. We applied validated instruments to assess HL and FL, and salt awareness. Multiple linear regression was used to investigate the association of explanatory variables with salt intake, K intake, and Na/K. Mean daily salt intake was 8.9 g, K 3.1 g, and Na/K 1.18. Salt intake was associated with sex ( $p < 0.001$ ), and K intake with sex ( $p < 0.001$ ), age ( $p = 0.02$ ), and waist-to-height ratio ( $p = 0.03$ ), as was Na/K. HL index and FL score were not significantly associated with salt or K intake but the awareness variable “salt content impacts food/menu choice” was associated with salt intake ( $p = 0.005$ ). *Conclusion:* To achieve the established targets for population Na and K intake, health-related knowledge, abilities, and skills related to Na/salt and K intake need to be promoted through combined educational and structural interventions.

Clinical Trials Registry number: DRKS00006790 (23/09/2014).

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## Introduction

Hypertension is a major cause of cardiovascular diseases (CVD) affecting a high and growing proportion of adults

worldwide. The development of high blood pressure (BP) and progression of CVD is driven by a combination of social determinants, lifestyle, behavioral, and metabolic risk factors [1]. A diet characterized by low fruit and vegetable

**Abbreviations:** BMI, Body mass index; BP, Blood pressure; CVD, Cardiovascular diseases; FL, Food literacy; HL, Health literacy; K, Potassium; Na, Sodium; WHO, World Health Organization; WHtR, Waist-to-height ratio.

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intake and regular consumption of foods rich in salt and fat increases the risk of hypertension [1] also due to related micronutrient intakes, particularly sodium (Na) and potassium (K) [2,3].

Evidence suggests that high Na intake is a modifiable, age-dependent risk factor for elevated BP and hypertension [4,5]. Increased K intake is associated with reduced blood pressure and CVD risk, and may counteract the negative consequences of high Na consumption [6–8]. In addition, the joint effects of a low Na and high K intake may be greater than the effect of either Na or K alone, particularly among hypertensive adults [9,10]. The World Health Organization (WHO) recommends daily intakes of salt < 5 g per day, Na < 2 g (87 mmol) per day, K > 3.5 g (90 mmol) per day [11], and a Na/K-ratio (by weight) < 0.6 [12]. In Switzerland, the mean intake of salt (men 11 g/day, women 8 g/day) is above the WHO recommendation and the mean intake of potassium (men 3 g/day, women 2.5 g/day) is below the WHO recommendation; similar salt and potassium departures from recommendations obtain in most western countries [13–16]. The Swiss salt strategy calls for an interim mean salt intake of <8 g/day and in the long-term an intake of 5 g/day [17]. The Swiss strategy for noncommunicable diseases recommends strengthening health promotion and health literacy (HL) to encourage more healthy dietary behavior [18]. HL and its nutrition-specific form food literacy (FL) are recognized, important resources for health promoting behavior [19]. HL “entails people’s knowledge, motivation and competences to access, understand, appraise, and apply health information in order to make judgments and take decisions ... concerning healthcare, disease prevention and health promotion” [20]. FL more specifically covers many abilities and skills needed for health-promoting food decisions in various situations and settings [21]. Similarly, awareness of salt consumption has been shown to be important for lowering salt intake [22,23].

The possible relationship of HL, FL, and/or salt awareness to Na and K intake, and to the Na/K ratio has not yet been investigated and is the object of this study, which analyzes the baseline data of a combined environmental and educational intervention trial to reduce salt intake in the Swiss working population [24]. The primary outcome of this nonrandomized, single-arm trial with calibration arm was measurement of 24-h urinary Na excretion. The trial was approved by swissethics, the Swiss Ethics Committees on research involving humans (KEK BE 130/14, PB\_2016\_01156), and registered in the German Clinical Trials Register (DRKS00006790).

## Methods

### Setting and study participants

The baseline data of 145 employees between the ages of 15 and 65 who had differing positions in one of eight social services, production/service, university/research, or public service organizations located in the German speaking part of Switzerland, each of which had a staff canteen, were

included in the analysis. Participants had to meet three criteria to be included: use of the staff canteen at least once weekly, availability every three months for nutrition workshops provided during regular working hours, and sufficient knowledge of German.

We excluded participants with medical or nonmedical indications and/or medication use that would influence urine collection and analysis, as well as those suffering from any food allergy or intolerance that prevented eating in the canteen. The sample size of 145 employees exceeded a threshold of 112 participants, which is the number of participants we calculated would be necessary to detect a reduction in the primary endpoint (24-h urinary Na excretion) by 15% with alpha 0.05 and 80% power, which also would allow for 10% drop-out. All further analyses were considered exploratory and hypothesis generating.

All study participants gave written consent.

### Data collection

Baseline data were collected from April to October 2015. Trained research staff conducted anthropometric and BP measurements at the workplace, and provided oral and written instructions on urine collections and completion of questionnaires.

### Na and K excretion in 24 h-urine

Participants collected urine during a previously agreed upon 24-h period following the WHO/PAHO standard protocol [25]. In summary, on the day of urine collection the first morning urine was discarded (start time) and all urine voided thereafter was collected through the next morning until approximately 24 h after starting (finish time). Participants recorded collection start and finish times, missed/spoiled urine collections, and medication use.

Urine analysis was done by a medical laboratory in Bern, Switzerland (Dr. Risch). Sample volume was gravimetrically measured. Na and K concentrations (mmol/L) were analyzed with an indirect ion selective electrode technique (Roche eLabDoc ISE indirect Na–K–Cl for Gen.2 Global, V9.0). For samples with Na concentration below the detection limit (20 mmol/L), a retained aliquot was analyzed in the laboratories of the Federal Food Safety and Veterinary Office (FSVO Bern, Switzerland) by inductively coupled plasma optical emission spectrometry (ICP–OES, iCAP 6500 dual view, Thermo). Urine creatinine concentration ( $\mu\text{mol/L}$ ) was estimated by the kinetic Jaffe method (Roche eLabDoc Creatinin Jaffé Gen.2, V17.1), and 24-h excretion was compared with Swiss 24-h creatinine reference values to evaluate quality of urine collection [26]. We accepted collection durations of 24 h  $\pm$  4 h (20–28 h) and standardized measurements to a 24-h period. However, urine samples were considered unacceptable if total volume was below 300 mL, two or more collections were missed, or urinary creatinine excretion was above 400  $\mu\text{mol/kg/24 h}$ .

Of 145 consenting participants, 142 returned urine specimens, one of which was unacceptable due to low volume (238 mL) and excluded. In the remaining 141

acceptable samples, 124 (87%) had adequate creatinine values [26]. In a sensitivity analysis of the 141 acceptable samples, we compared Na, K, and NaCl of (a) the inadequate and adequate samples, (b) the inadequate and all acceptable samples, and (c) the adequate and all acceptable samples. Among the acceptable samples, we allowed relative differences of up to  $\pm 15\%$  for the inclusion of all acceptable samples in the analysis [27]. No differences at group level were found, and therefore all 141 samples were included in the analysis.

### Na/NaCl and K intake estimation

We predicted Na and K intake from urinary excretion without correction for other losses, likely to be fairly minor, via sweat or feces, since prediction from urinary excretion alone is considered feasible, and has good predictive power [28]. The daily Na and K excretion/intake estimates by weight (mg/24 h or g/day) were calculated by multiplying laboratory values (mmol/24 h) with respective atomic weights (Na 23 mg/mmol, K 39.1 mg/mmol). The Na and K estimates (g/day) yielded the ratio. Daily salt equivalent intake (short salt intake, NaCl g/day) was calculated by multiplying the Na intake estimate (g/day) by the Na + Cl to Na atomic weight ratio of 2.54.

### Health literacy, food literacy, and salt awareness

Participants completed a 68-item, self-administered questionnaire at baseline that obtained information on sex, age, educational level (primary, secondary, or tertiary), smoking status (never, former, current), physical activity, health and food literacy, as well as specific aspects of salt awareness.

HL was selectively measured using the 16 items comprising the health promotion domain of the validated European Health Literacy questionnaire (HLS-EU-Q47, German version) [29]. Provided 80% of the four-point Likert scale items were available, an HL index (0–50 points) was calculated as recommended by the HLS-EU Consortium [30], which affords HL categorization as inadequate ( $\leq 25$ ), problematic ( $> 25$ –33), sufficient ( $> 33$ –42) or excellent ( $> 42$ –50).

FL was measured using a validated, short 12-item questionnaire of four- or five-point Likert scales [31], which covered crucial elements of nutrition literacy and food literacy definitions [21]. For evaluation, a summary score was calculated that ranged from 7 to 52; the higher the score, the better the FL.

For salt awareness, we considered three specific issues that addressed salt-related knowledge and behavior. These were (1) knowledge of the Swiss salt intake recommendation, (2) the use of discretionary salt when eating at home and away from home, and (3) the impact of the salt content of a food or menu item on purchasing/choosing it, or not, when shopping for groceries or eating in a staff canteen. We recoded related questions as binary (yes/no) variables.

### Anthropometric and blood pressure measures

Anthropometric measurements followed international procedures [32]. Participants wore light clothing and no

shoes for body weight and height measurements using a digital flat scale (seca 803, 0.1 kg) and a mobile stadiometer (seca 217, 0.1 cm). To account for the average weight of garments, 1.0 kg was subtracted from each weight measurement.

Waist circumference was measured halfway between the iliac crest and the lower rib, using an ergonomic circumference measuring tape (seca 201, 0.1 cm). The measurement was taken twice; if the two differed by more than 0.5 cm, a third was taken. The mean of the two closest measurements was calculated.

The study included measures of weight status/obesity and related cardiometabolic risk, calculating body mass index (BMI, weight divided by height squared [ $\text{kg}/\text{m}^2$ ]), and waist-to-height ratio (WHtR) [33]. BP was measured according to European guidelines [34] using an OMRON HEM-907 validated automatic measuring device and suitably sized cuffs. Participants were seated in a quiet room, at rest for ca. five minutes prior to three consecutive measurements taken 1 min apart on their previously identified reference arm. The mean of the last two readings was used. Hypertension was defined as any one (or more) of systolic BP  $> 140$  mmHg, diastolic BP  $> 90$  mmHg, or being on antihypertensive treatment.

Study data were collected and managed using REDCap (Research Electronic Data Capture) hosted at the Clinical Trials Unit, University of Bern [35].

### Statistical analysis

Characteristics of study participants were summarized using means and 95% confidence intervals for continuous variables and frequency, and percentages for categorical variables. We used multiple linear regression models with backward selection to investigate the association of the explanatory variables sex, age, education, hypertension, smoking, physical activity, WHtR, and BMI with salt intake, K intake, and Na/K. Before applying the models, pairwise correlations between the variables were investigated to avoid multicollinearity. As BMI and WHtR were highly correlated (Pearson correlation  $r = 0.91$ ), the models were calculated separately, once with BMI and once with WHtR; the models with WHtR were chosen as they had the higher adjusted  $R$ -squared. The three salt awareness variables were also correlated. The variable with the highest association with the target variables, salt content impacts food/menu choice, was included in the models. To investigate the association of HL index, FL score, and the variable salt content impacts food/menu choice with salt intake, K intake, and Na/K, multiple linear regression models were separately applied for each of these variables including the explanatory variables that were significant after backward selection. To investigate sex-related differences we conducted separate analyses for men and women.

Two-tailed tests with significance level 0.05 were used for all analyses. Because our analysis was exploratory and hypothesis generating, no adjustment for multiple testing was done. All analyses were performed using R 3.3.2 (<http://www.r-project.org>).

## Results

### Characteristics of study participants

Table 1 shows characteristics of the 141 study participants (mean age 45 years) with complete 24-h urine specimens.

The majority were nonhypertensive, nonsmoking and physically active, highly educated, and on average had fair a HL index and FL score. Only 19 participants (13.5%) gave a positive answer on all three salt awareness items; the remaining 86.5% reported being unaware of at least one item (data not shown). About half of participants knew the maximum recommended salt intake, indicated no discretionary salt use, and reported that salt content influences

their decision to purchase/choose a food or menu item, or not.

### Salt intake, K intake, and Na/K ratio

Table 2 shows results for salt intake, K intake, and the Na/K ratio for all study participants by sex, HL, FL, salt awareness, and hypertension.

Means of salt intake, K intake, and the Na/K ratio were all higher in men than in women. Participants with excellent HL had lower mean salt intake compared to those in lower HL categories. Mean K intake and Na/K were almost identical across HL categories. Salt-aware persons who reported knowing the salt recommendation, not using discretionary salt, who considered salt content of foods/menus at time of purchase had lower mean salt intakes than salt-unaware counterparts. Hypertensive participants had higher mean salt intake than normotensive participants. While they varied, K intake and Na/K did not differ greatly across all groups.

### Multiple linear regression models

Results of the best models for salt and K intake are presented in Table 3. After adjusting for all explanatory variables, only sex was significantly associated with salt intake ( $p < 0.001$ ). Compared to men, the average salt intake of women was 3.5 g (95% CI 2.4, 4.6) per day lower. After backward selection, sex was the only remaining significant variable in the model (data not shown). Potassium intake was significantly associated with sex ( $p < 0.001$ ), age ( $p = 0.02$ ), and WHtR ( $p = 0.03$ ).

Table 4 shows results of the multiple regression models exploring the association of HL index, FL score, and the variable salt content impacts food/menu choice with salt and K intake. The models included only significant explanatory variables for salt (sex) and potassium intake (sex, age, and waist-to-height-ratio) (Table 3). There was no significant association between HL index and FL score with salt intake. The only variable significantly associated with salt intake ( $p = 0.005$ ) was salt content impacts food/menu choice. Participants indicating that salt content influences their decision to purchase/choose a food or menu item, or not, had a 1.5 g (95% CI 0.5, 2.6) lower daily salt intake. Together with sex, this variable explained 27.2% of variability (adjusted  $R$ -squared) in salt intake. Regarding potassium intake, we found no significant association with HL index and FL score, but a borderline association with salt content impacts food/menu choice.

Table 5 shows the best model for Na/K. After backward selection, sex, age, and WHtR remained significantly associated with Na/K. Being female, older, and having lower WHtR was associated with a lower ratio. These variables accounted for 13.9% of variability (adjusted  $R$ -squared) in Na/K.

The effect of HL, FL, and salt content impacts food/menu choice on Na/K (Supplementary Table S1) was not significant. Sex-specific full models (Supplementary Tables S2–S4) showed no significant associations for males. In

**Table 1** Characteristics of the study population.

| Variable                              | n    | %            |
|---------------------------------------|------|--------------|
| Sex                                   |      |              |
| Men                                   | 71   | 50.4%        |
| Women                                 | 70   | 49.6%        |
| Education                             |      |              |
| Primary                               | 2    | 1.4%         |
| Secondary                             | 35   | 24.8%        |
| Tertiary                              | 104  | 73.8%        |
| Health literacy index                 |      |              |
| Excellent                             | 11   | 7.8%         |
| Sufficient                            | 51   | 36.2%        |
| Problematic                           | 61   | 43.3%        |
| Inadequate                            | 18   | 12.8%        |
| Salt awareness                        |      |              |
| Know salt recommendation              |      |              |
| Yes                                   | 73   | 51.8%        |
| No                                    | 68   | 48.2%        |
| Discretionary salt use                |      |              |
| Yes                                   | 66   | 46.8%        |
| No                                    | 75   | 53.2%        |
| Salt content impacts food/menu choice |      |              |
| Yes                                   | 61   | 43.3%        |
| No                                    | 80   | 56.7%        |
| Hypertension <sup>a</sup>             |      |              |
| Yes                                   | 22   | 15.6%        |
| No                                    | 119  | 84.4%        |
| Smoking                               |      |              |
| Never                                 | 81   | 57.9%        |
| Former                                | 38   | 27.1%        |
| Current                               | 21   | 15.0%        |
| <NA>                                  | 1    | 0.7%         |
| Physical activity <sup>b</sup>        |      |              |
| Meeting WHO recommendation            |      |              |
| Yes                                   | 122  | 87.1%        |
| No                                    | 18   | 12.9%        |
| <NA>                                  | 1    | 0.7%         |
| Continuous variables                  | Mean | 95% CI       |
| Age (years)                           | 44.6 | [42.8, 46.4] |
| Waist-to-height ratio (WHtR)          | 0.84 | [0.83, 0.85] |
| Health literacy index <sup>c</sup>    | 32.4 | [31.4, 33.5] |
| Food literacy score <sup>d</sup>      | 36.1 | [35.0, 37.1] |

<sup>a</sup> Systolic blood pressure (BP)  $\geq 140$  mmHg and/or diastolic BP  $\geq 90$  mmHg and/or current intake of BP lowering drugs [34].

<sup>b</sup> acc. GPAQ [36], 150 min moderate-intensity PA or 75 min vigorous-intensity PA, or equivalent combination achieving 600 + MET per week.

<sup>c</sup> HL index 0–50 [30], more points = more literate.

<sup>d</sup> FL score 7–52 [31], more points = more literate.



**Table 2** Mean salt intake (g/day), potassium intake (g/day), and Na/K ratio overall by sex, health literacy, salt awareness, and hypertension based on Na and K in 24-h urine.

| Variables                             | Salt intake (g/day) |             | Potassium intake (g/day) |            | Na/K ratio (by weight) |              |
|---------------------------------------|---------------------|-------------|--------------------------|------------|------------------------|--------------|
|                                       | Mean                | 95% CI      | Mean                     | 95% CI     | Mean                   | 95% CI       |
| All (n = 141)                         | 8.9                 | [8.3, 9.5]  | 3.1                      | [3, 3.3]   | 1.18                   | [1.1, 1.26]  |
| Sex                                   |                     |             |                          |            |                        |              |
| Men                                   | 10.7                | [9.8, 11.7] | 3.4                      | [3.2, 3.7] | 1.29                   | [1.17, 1.4]  |
| Women                                 | 7.1                 | [6.6, 7.6]  | 2.8                      | [2.6, 3]   | 1.07                   | [0.97, 1.17] |
| Health literacy index                 |                     |             |                          |            |                        |              |
| Excellent                             | 8.4                 | [5.9, 10.2] | 3.1                      | [2.5, 3.7] | 1.15                   | [0.77, 1.52] |
| Sufficient                            | 8.9                 | [7.6, 10.2] | 3.2                      | [2.8, 3.6] | 1.13                   | [0.95, 1.31] |
| Problematic                           | 9.1                 | [8.1, 10.1] | 3.1                      | [2.8, 3.4] | 1.18                   | [1.08, 1.29] |
| Inadequate                            | 8.9                 | [7.8, 9.9]  | 3.1                      | [2.8, 3.3] | 1.2                    | [1.04, 1.35] |
| Food literacy score <sup>a</sup>      |                     |             |                          |            |                        |              |
| upper tertile                         | 8.4                 | [7.2, 9.5]  | 3.2                      | [2.9, 3.5] | 1.05                   | [0.91, 1.19] |
| middle tertile                        | 8.9                 | [8, 9.9]    | 3.1                      | [2.8, 3.4] | 1.2                    | [1.08, 1.33] |
| lower tertile                         | 9.4                 | [8.4, 10.5] | 3.1                      | [2.8, 3.3] | 1.27                   | [1.14, 1.41] |
| Salt awareness                        |                     |             |                          |            |                        |              |
| Know salt recommendation              |                     |             |                          |            |                        |              |
| Yes                                   | 8.4                 | [7.7, 9.1]  | 3.1                      | [2.9, 3.3] | 1.1                    | [1, 1.19]    |
| No                                    | 9.5                 | [8.5, 10]   | 3.1                      | [2.8, 3.4] | 1.27                   | [1.14, 1.39] |
| Discretionary salt use                |                     |             |                          |            |                        |              |
| Yes                                   | 9.2                 | [8.4, 10.1] | 3.2                      | [2.9, 3.4] | 1.19                   | [1.09, 1.3]  |
| No                                    | 8.6                 | [7.7, 9.5]  | 3.1                      | [2.8, 3.3] | 1.16                   | [1.05, 1.27] |
| Salt content impacts food/menu choice |                     |             |                          |            |                        |              |
| Yes                                   | 7.9                 | [7, 8.8]    | 2.9                      | [2.7, 3.2] | 1.09                   | [0.97, 1.21] |
| No                                    | 9.7                 | [8.9, 10.5] | 3.3                      | [3, 3.5]   | 1.25                   | [1.15, 1.35] |
| Hypertension                          |                     |             |                          |            |                        |              |
| Yes                                   | 9.4                 | [7.6, 11.2] | 3.2                      | [2.8, 3.6] | 1.19                   | [1, 1.38]    |
| No                                    | 8.8                 | [8.2, 9.5]  | 3.1                      | [2.9, 3.3] | 1.18                   | [1.09, 1.26] |

<sup>a</sup> FL score tertiles lower  $\leq 34.4$ , middle 34.5–39.2, upper  $> 39.2$ .

women, age and WHtR were significantly associated with potassium intake and Na/K. Salt intake was significantly associated with the variable salt content impacts food/menu choice only in women (data not shown).

## Discussion

This is to our knowledge the first study to examine the association of HL, FL, and salt-awareness with salt intake, K

intake, and Na/K in a workplace setting in Switzerland, if not elsewhere as well. Other studies have mostly examined consumers' knowledge and practices related to salt intake [37–40], while only a few have investigated associations with salt intake [41,42].

## Main findings

The majority of our study participants were well educated and health conscious, physically active nonsmokers who reported good health. Their mean salt and K intake as well as Na/K ratio did not meet WHO recommendations, which is in line with earlier Swiss [27,43,44] and international [13–16,45] studies. Our findings suggest that sex by itself plays a significant role in explaining variability in salt intake, and as in other countries the intake of men is higher than that of women [46]. On the other hand, sex, age, and WHtR best explained variability in K intake and Na/K. Sex-specific analysis confirmed the associations of age and WHtR with K intake and Na/K, but only for women. In particular, lower WHtR was associated with higher K intake and lower Na/K. These sex-related differences could be explained by either a better balanced diet including more fruit and vegetables, or by differences in energy intake [41,47,48].

## Minor importance of HL, FL, and salt awareness

We observed a tendency towards lower salt intake among health literate, food literate, and salt-aware participants (Table 2). Still, nearly half of the well educated study participants had a problematic level of HL, which confirms the results of a recent Swiss survey [49]. Previous research has linked poor HL with lower levels of educational achievement [50]. However, HL reflects not only formal education (schooling) but increased skill and ability to obtain practical health-related knowledge [51,52]. This might explain the fair mean score observed for FL, a specific form of HL that focuses on skills and abilities related to food choice [21]. Nevertheless, in multiple regression analysis neither HL nor FL were significantly associated with salt intake, K intake, and Na/K. Of three salt awareness variables concerning salt-related knowledge and behavior, salt content impacts food/menu choice had the highest association with the target

**Table 3** Full model for daily salt and potassium intake (explanatory variables).

| Variables                                 | Salt intake |               |         | Potassium intake |               |         |
|---|-------------|---------------|---------|------------------|---------------|---------|
|   | Estimate    | 95% CI        | p-Value | Estimate         | 95% CI        | p-Value |
| Intercept                                 | 8.3         | [3.3, 13.2]   | 0.001   | 3.9              | [2.5, 5.4]    | <0.001  |
| Sex (women vs men)                        | −3.5        | [−4.6, −2.4]  | <0.001  | −0.7             | [−1, −0.3]    | <0.001  |
| Age                                       | −0.01       | [−0.07, 0.04] | 0.6     | 0.02             | [0.003, 0.04] | 0.02    |
| Waist-to-height ratio (WHtR)              | 4.6         | [−4.8, 14.0]  | 0.3     | −3.1             | [−5.8, −0.4]  | 0.03    |
| Education (tertiary vs primary/secondary) | 0.5         | [−0.8, 1.7]   | 0.5     | 0.06             | [−0.3, 0.4]   | 0.8     |
| Hypertension (yes <sup>a</sup> vs no)     | −0.2        | [−1.8, 1.5]   | 0.9     | −0.04            | [−0.5, 0.5]   | 0.9     |
| Smoking (former vs never)                 | 1.0         | [−0.3, 2.2]   | 0.1     | 0.3              | [−0.1, 0.6]   | 0.2     |
| Smoking (current vs never)                | 1.1         | [−0.6, 2.8]   | 0.2     | 0.4              | [−0.08, 0.9]  | 0.1     |
| Adjusted R-squared                        | 0.236       |               |         | 0.1299           |               |         |

<sup>a</sup> Systolic blood pressure (BP)  $\geq 140$  mmHg and/or diastolic BP  $\geq 90$  mmHg and/or current intake of BP lowering drugs.

**Table 4** Health literacy index, food literacy score, and salt impact models for daily salt and potassium intake.

| Model  | Health literacy |                 |                                    | Food literacy |                |                                    | Salt impacts food choice |               |                 |
|--|-----------------|-----------------|------------------------------------|---------------|----------------|------------------------------------|--------------------------|---------------|-----------------|
| Variable                                     | Estimate        | 95% CI          | <i>p</i> -Value                    | Estimate      | 95% CI         | <i>p</i> -Value                    | Estimate                 | 95% CI        | <i>p</i> -Value |
| Salt intake                                  |                 |                 |                                    |               |                |                                    |                          |               |                 |
| Intercept                                    | 10.4            | [7.5, 13.3]     | <0.001                             | 10.3          | [7.2, 13.5]    | <0.001                             | 9.8                      | [8.8, 10.7]   | <0.001          |
| Sex (women vs men)                           | −3.6            | [−4.6, −2.5]    | <0.001                             | −3.7          | [−4.8, −2.6]   | <0.001                             | −3.4                     | [−4.5, −2.4]  | <0.001          |
| Health literacy index                        | 0.008           | [−0.078, 0.095] | 0.8                                | —             | —              | —                                  | —                        | —             | —               |
| Food literacy score                          | —               | —               | —                                  | 0.01          | [−0.08, 0.1]   | 0.8                                | —                        | —             | —               |
| Salt content impacts food choice (no vs yes) | —               | —               | —                                  | —             | —              | —                                  | 1.5                      | [0.5, 2.6]    | 0.005           |
| Adjusted <i>R</i> -squared: 0.230            |                 |                 | Adjusted <i>R</i> -squared: 0.238  |               |                | Adjusted <i>R</i> -squared: 0.272  |                          |               |                 |
| Potassium intake                             |                 |                 |                                    |               |                |                                    |                          |               |                 |
| Intercept                                    | 4.0             | [2.3, 5.7]      | <0.001                             | 3.3           | [1.6, 5.2]     | <0.001                             | 3.9                      | [2.6, 5.2]    | <0.001          |
| Sex (women vs men)                           | −0.7            | [−1.0, −0.3]    | <0.001                             | −0.7          | [−1.0, −0.4]   | <0.001                             | −0.6                     | [−0.9, −0.3]  | <0.001          |
| Age  | 0.02            | [0.001, 0.03]   | 0.03                               | 0.02          | [0, 0.03]      | 0.053                              | 0.03                     | [0.002, 0.03] | 0.02            |
| Waist-to-height ratio (WHtR)                 | −2.6            | [−5.2, 0.05]    | 0.055                              | −2.4          | [−5.1, 0.2]    | 0.07                               | −2.9                     | [−5.5, −0.3]  | 0.03            |
| Health literacy index                        | −0.001          | [−0.03, 0.03]   | 1.0                                | —             | —              | —                                  | —                        | —             | —               |
| Food literacy score                          | —               | —               | —                                  | 0.02          | [−0.008, 0.05] | 0.2                                | —                        | —             | —               |
| Salt content impacts food choice (no vs yes) | —               | —               | —                                  | —             | —              | —                                  | 0.3                      | [−0.03, 0.6]  | 0.07            |
| Adjusted <i>R</i> -squared: 0.1233           |                 |                 | Adjusted <i>R</i> -squared: 0.1419 |               |                | Adjusted <i>R</i> -squared: 0.1443 |                          |               |                 |

**Table 5** Best model for Na/K ratio.

| Variables                    | Estimate | 95% CI          | p-Value |
|------------------------------|----------|-----------------|---------|
| Intercept                    | 0.81     | [0.18, 1.43]    | 0.01    |
| Sex (women vs men)           | −0.21    | [−0.36, −0.06]  | 0.007   |
| Age                          | −0.01    | [−0.02, −0.004] | 0.002   |
| Waist-to-height ratio (WHtR) | 1.96     | [0.75, 3.17]    | 0.002   |
| Adjusted R-squared: 0.139    |          |                 |         |

variables. Considering salt content when choosing food/menu items is an ability/behavior that represents an advanced form of FL (in interactive and critical form), which is the ability to assess whether a food contributes to healthy nutrition and to distinguish between more healthy and less healthy options [53]. At least some of the participants (43%) apparently were able to make a healthy food choice and apply nutrition information to their own situation. To do so requires good functional food literacy such as knowing recommendations and being able to read and understand labels (which 30% of participants regularly do) [53]. Just over half of participants knew the recommended level of salt intake and indicated no use of discretionary salt. This finding is consistent with reports from other studies [23,54], but we suspect that participants may have misinterpreted the intermediate Swiss salt strategy target (<8 g) as a maximum level/recommendation. The fact that some of the study participants were aware of the recommended level but still used discretionary salt and did not consider salt content when choosing food/menu items suggests that knowledge is not the same thing as practice. Whatever the potential of HL, FL, and specific salt awareness, the high content of sodium in processed foods may hamper consumers' efforts to reduce overall sodium intake. This highlights the importance of reformulation of food products while nevertheless taking into consideration the fact that taste is one of the most important determinants influencing discretionary salt use [55].

### Strengths and limitations

We analyzed baseline data from a one-year workplace health promotion trial. Although the workplace is a valuable setting for health promotion interventions [56], the nature of the study did not allow us to either establish any causal relationships or generalize our findings to the working population of Switzerland. The trial also was restricted to the German-speaking region of the country, and the sample size was limited by the low response rate of the organizations that were potentially available. The overall sample from the organizations that did participate was highly educated and probably interested in nutrition related issues. In addition, participating employees did not equally represent all positions (e.g., management, workers).

An important strength of the study is its use of 24-h urine collection, the standard clinical method recommended by WHO to measure salt intake [25]. Although a single urine collection, even over 24 h, may not be representative of individual habitual Na and K intake, it is considered an acceptable proxy for intake at the group level [57]. We assessed a wide range of factors related to Na and K intake that included sociodemographic and behavioral, health lifestyle characteristics. We assessed HL and FL with validated instruments [30,31]. We considered some recognized methods to assess salt awareness, but they rely mostly on self-rated measures and as such are prone to bias [31]. While the HL and FL instruments cover a range of general health and nutrition-related issues, they may thus be less sensitive to use than concrete salt-awareness measures.

### Conclusions

Although further research is warranted to determine whether our findings are also valid for the general population, our analysis strongly emphasizes the need to raise

health-related knowledge, abilities, and skills regarding Na/salt and K in the working population of Switzerland and, in particular, to bridge the gap between knowledge and salt-related dietary practices. Combined educational measures and structural interventions at the food system level, including reformulation of processed foods, are needed to achieve the established targets for population sodium and potassium intake.

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## Conflicts of interest

The authors declare that there are no conflicts of interest.

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## Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.numecd.2017.10.028>.

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